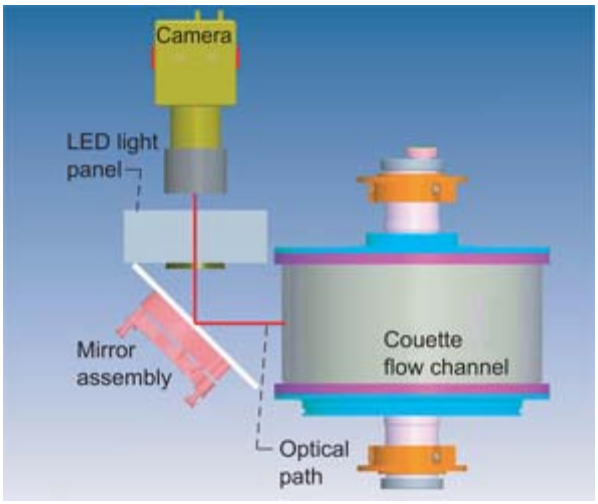
System Developed for Bulk Flow Imaging of a Two-Phase Fluid in a Cylindrical Couette

The Microgravity Observation of Bubble Interactions (MOBI) experiment is working to better understand the physics of gas-liquid suspensions. To study such suspensions, researchers generate bubbles in a large cylindrical flow channel. Then, they use various types of instrumentation, including video imaging, to study the bubbly suspension.

Scientists will need a camera view of the majority of the gas-liquid suspension inside of the couette in order to gather the information needed from the MOBI experiment. This will provide the scientists with a qualitative picture of the flow that may indicate flow instabilities or imperfect axial mixing inside the couette. These requirements pose a significant challenge because the imaging and lighting system must be confined to a very tight space since the space available on the International Space Station experiment racks is very limited. In addition, because of the large field of view needed and the detail needed to see the gas-liquid suspension behavior in the image, a digital video camera with high resolution (1024 by 1024 pixels) had to be used. Although the high-resolution camera will provide scientists with the image quality they need, it left little space on the experiment rack for the lighting system. Many configurations were considered for the lighting system, including frontlighting and backlighting, but because of mechanical design limitations with the couette, backlighting was not an option.

The next aspect of the design to be considered was the light source. Heat production had to be kept to a minimum, so light-emitting diodes (LEDs) were the most viable option because of their efficiency and low heat production. The lighting system developed consisted of a light panel populated with 615 LEDs on a 140-mm square. The light panel was designed with a hole in the center for the camera to view through. The panel produced enough light, but it produced severe glare on the front of the couette, so a linear polarizer was mounted on the front of the LED panel and on the camera lens to eliminate the glare. Then, the polarizer on the camera was adjusted to remove the glare from the front surface of the couette.



MOBI bulk-flow imaging layout. LED, light-emitting diode.
Long description of figure. Light path for imaging. Camera is upper left, chamber is lower right.

This imaging hardware has been tested in the lab and produces good quality images of the bubbles in a mockup of the flow channel. However, because fast-moving bubbles will have to be imaged, the light panel design may be updated to include more LEDs. This experiment is currently scheduled to fly on the International Space Station in 2008.

Find out more about this research at
http://microgravity.grc.nasa.gov/6712/overviews/MOBIover.html

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